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A Model of Outsourcing and Foreign Direct Investment

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Abstract

This paper presents a model in which two firms may use foreign direct investment or outsourcing in order to reduce the production cost of an intermediate input. Outsourcing requires training which is costly and creates a positive spillover. The paper shows that the equilibrium depends on the level of training costs. If they are high, only bilateral outsourcing is possible in equilibrium. If bilateral outsourcing is incomplete, it will not change prices compared to no outsourcing. If they are low, only complete outsourcing is possible. If complete outsourcing is unilateral (bilateral), the price increases (decreases) with the degree of spillovers.

JEL-Classification: F12, F23.

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1 Introduction

The era of globalization can be characterized by a substantial increase in multinational and cross-border activities of firms. Both outsourcing and foreign direct investment (FDI) have played a major role in this process. As for outsourcing, it has been shown that firms have locally disintegrated the production process substantially, such that production of intermediate inputs have been moved away from the place of the assembly of the final product (see, for example, Feenstra (1998) and Hummels, Ishii and Yi (2001)). At the same time, FDI has become more important than trade because the aggregate sales by foreign affiliates have outnumbered world exports (see the last editions of UNCTAD's World Investment Report).

These new facts have motivated the study of the theory of the multinational firm. The literature distinguishes between horizontal FDI (Markusen, (1984), Horstmann and Markusen (1992), Markusen and Venables (1998, 2000), De Santis and Stähler (2004)), which is undertaken to place production closer to foreign markets, and vertical FDI (Helpman (1984), Helpman and Krugman (1985)), which is undertaken to exploit lower production costs in order to serve both the domestic and the foreign markets. Thus, FDI can substitute for trade, when production in the host country replaces exports (horizontal FDI), but it can be complementary to trade, when a part of the production in the host country is shipped back to the home country (vertical FDI). For a survey of this literature, see Markusen (2002).

We will consider vertical FDI as an alternative to outsourcing, as outsourcing "slices the value chain" and is thus a vertical activity. Several papers have considered outsourcing as an endogenous response to how a firm is organized if it needs specialized inputs. Grossman and Helpman (2002a,b) have discussed the trade off between a vertically integrated firm and an outsourcing firm when outsourcing is based on incomplete contracts with suppliers. Based upon this work, Marin and Verdier (2003) have developed a theory which merges international trade theory and the theory of the firm. Grossman and Helpman (2003) themselves also have taken this issue further and have developed a model which explains the trade off between outsourcing

and FDI. They show that a reduction in contractual incompleteness will favor outsourcing relative to FDI.

The majority of these models employ a monopolistic competition framework. This has the advantage that incomplete substitutability, free market entry and repercussions from a change in income patterns can be taken into account. However, the monopolistic competition framework is not good at explaining strategic effects when only a few players dominate an industry. This is the reason why this paper employs a Cournot duopoly model as we would like to explore the strategic interaction between outsourcing and FDI. Furthermore, a very important reason for FDI and the establishment of multinational enterprises is the incentive to avoid positive spillovers to a (potential) rival firm. This reflects the incompleteness of contracts with independent suppliers. FDI aims at avoiding any knowledge diffusion. Therefore, we will model FDI as creating no spillovers, whereas outsourcing will produce spillovers.¹ The innovation of our contribution will be that we will consider the spillover between two firms which are of the same source region. Furthermore, we will determine the firm type endogenously and will explain when firms will diversify their production, *i.e.*, when outsourcing will be incomplete.

To our knowledge, the only paper which has discussed the effects of spillovers from outsourcing in a Cournot setting is Van Long (2005). In his model, a foreign firm may outsource part of its production to another country. A local rival firm is located in this country and produces an imperfect substitute. If outsourcing occurs, the foreign rival enjoys a positive spillover because outsourcing increases labor productivity in this country. The paper shows that outsourcing will be complete if both firms are monopolists in their markets, but will be incomplete if the two goods are substitutes. The reason is that the foreign firm would like to restrict the positive spillover to the local rival.

Our model will not assume a local rival but will consider the impact of spillovers on two foreign firms. A firm may make an investment in this

¹For a survey on the international patterns of technology diffusion, see Keller (2004).

country, and by doing so, it will be able to internalize all production activities. Alternatively, a firm may go for outsourcing which requires training of the workforce. These training activities produce a positive spillover to the other firm's activities in the host country. We will show that incomplete outsourcing is possible in equilibrium if training costs are not too low.

The remainder of the paper is organized as follows. Section 2 will introduce the model and demonstrate the possible equilibria without outsourcing. Section 3 will discuss the case of bilateral outsourcing, *i.e.*, both firms train foreign workers, and Section 4 will present the case of unilateral outsourcing, *i.e.*, one firm will go for FDI whereas the other firm will train foreign workers. Section 5 will summarize the possible equilibria.

2 The model

The model is as simple as possible. Two firms 1 and 2 serve a world market whose inverse demand function is $p = a - bQ$, $a, b > 0$, where p denotes the price and Q denotes aggregate production. We will denote by i either firm 1 or firm 2, and j will denote the firm which is not i . There are two regions, labelled North and South, and skilled labor resides in the North only. The production process comprises two stages, upstream and downstream production, and downstream production is research-intensive and requires skilled labor such that it takes place in the North only. Without loss of generality, we assume that this part of the production process has zero marginal costs. Upstream production results in an intermediate input and can take place in both regions. We normalize production units such that producing one unit of the intermediate input requires one unit of unskilled labor. Furthermore, one unit of the intermediate product is needed by the downstream production process in order to produce one unit of the final good. The wage rate of unskilled labor is equal to $v(w)$ in the North (South) with $a > v > w$.

There are two ways of taking advantage of the wage differential between the North and the South, either by FDI or by outsourcing. In the case of FDI, the firm sets up a plant in the foreign country. Setting up this plant, however, warrants a fixed cost of size F . The FDI cost guarantees not only that the

plant can be run properly but also that there will be no spillover to other rival or local firms. The complete internalization of production activities is well accepted to be the main driving force for the establishment of multinational enterprises, and the investment F can be seen as the size of skilled labor from the North which is required to run a plant in the South without any spillover effect.

Outsourcing does not require a fixed cost but training of the workforce which is employed in the South.² The labor input in the South will be denoted by y , and its training costs are equal to $ty^2/2$ for a firm training y workers. Training costs are marginally increasing because the probability of finding talented workers at a certain location decreases with the number of workers already hired. Furthermore, training workers creates a positive externality for the other firm, for example because some workers may change occupation after they have been trained. We capture this spillover effect from training such that training of a workforce y_i by firm i reduces the rival j 's unit cost by γy_i with $\gamma > 0$. As for the parameters, we assume that $b > \gamma$ which will guarantee that the output variables are strategic substitutes in the sense of Bulow, Geanakoplos and Klemperer (1985). Let x denote the production level of the outsourcing firm in the North, and let z denote the output of the foreign plant set up by FDI. The two firms play the following three stage game:

Stage 1: Both firms decide simultaneously on FDI or outsourcing.

Stage 2: An FDI firm has to invest the fixed cost F , and an outsourcing firm i decides on the size of the workforce to be trained, y_i .

Stage 3: Firms decide simultaneously on output levels x_i and z_i .

As usual, the game will be solved by backward induction. Note that production levels are determined in stage 2 and stage 3. A firm which goes for

²Nothing would change if training requires a fixed cost as well. All that matters is that FDI warrants a larger fixed cost, so F can also be considered as the difference between fixed cost of FDI and training. Basically, the model assumes two different types of immobile unskilled labor, and unskilled labor in the North does not require any training. Unskilled labor in the South either need training or complementary skilled labor from the North.

outsourcing upstream production commits to a certain production level by training the foreign workforce. Furthermore, outsourcing must not be complete because an outsourcing firm may find it profitable to produce the intermediate input for downstream production in the North as well. In particular, our game structure does not allow a firm to commit to complete outsourcing unless this is the best response in the last stage. In the last stage, profit maximization leads to the first-order condition for the production level z_i of an FDI firm i ,

$$\begin{aligned} a - w - 2bz_i + \gamma y_i - bQ_{-i} &\leq 0, z_i \geq 0, \\ (a - w - 2bz_i + \gamma y_i - bQ_{-i})z_i &= 0, \end{aligned} \tag{1}$$

and the first order condition for an outsourcing firm j for its production level x_j in the North,

$$\begin{aligned} a - v - 2b(x_j + y_j) + \gamma y_{-j} - bQ_{-j} &\leq 0, x_j \geq 0, \\ (a - v - 2b(x_j + y_j) + \gamma y_{-j} - bQ_{-j})x_j &= 0, \end{aligned} \tag{2}$$

respectively, where $Q_{-i}(Q_{-j})$ denotes aggregate production net of $z_i(x_j)$, and $y_i(y_j)$ denotes the level of training by the other firm (which could be zero). Note that the model can also accommodate $z_i = 0$, *i.e.*, that FDI is not profitable, and $x_j = 0$, *i.e.*, that no production takes place in the North.

The case of $y_1 = y_2 = 0$ is the easiest to deal with. In this case, any firm not doing FDI does not outsource at all but all production takes place in the North. This case of no outsourcing coincides with the well-known case of national and multinational firms competing against each other.³ If both firms go for FDI, the equilibrium output and profit levels are

$$z_i = \frac{a - w}{3b}, \Pi_i = \frac{(a - w)^2}{9b} - F, \tag{3}$$

respectively. On the contrary, if both firms abstain from FDI and produce only in the North, production and profit levels are respectively equal to

³For a model of vertical FDI and trade, see Elberfeld, Götz and Stähler (2005).

$$x_i = \frac{a - v}{3b}, \Pi_i = \frac{(a - v)^2}{9b}. \quad (4)$$

Finally, firm i may go for FDI whereas firm j will produce in the North only, so that production and profit levels are equal to

$$\begin{aligned} x_i &= \frac{a - 2v + w}{3b}, z_j = \frac{a - 2w + v}{3b}, \\ \Pi_i &= \frac{(a - 2v + w)^2}{9b}, \Pi_j = \frac{(a - 2w + v)^2}{9b} - F. \end{aligned} \quad (5)$$

Table 1: Payoff matrix without outsourcing

| | | Firm 2 | |
|--------|--------|---|---|
| | | No FDI | FDI |
| Firm 1 | No FDI | $\left(\frac{(a-v)^2}{9b}, \frac{(a-v)^2}{9b}\right)$ | $\left(\frac{(a-2v+w)^2}{9b}, \frac{(a-2w+v)^2}{9b} - F\right)$ |
| | FDI | $\left(\frac{(a-2w+v)^2}{9b} - F, \frac{(a-2v+w)^2}{9b}\right)$ | $\left(\frac{(a-w)^2}{9b} - F, \frac{(a-w)^2}{9b} - F\right)$ |

Table 1 shows the strategic form for the first stage of the game. The equilibrium depends on the size of the FDI cost F , the size of the wage differential $v - w$ and the size of the world market, measured by the inverse of b . We may determine two critical levels of fixed cost,

$$\underline{F} = \frac{4(a - v)(v - w)}{9b}, \bar{F} = \frac{4(a - w)(v - w)}{9b}, \bar{F} - \underline{F} = \frac{4(v - w)^2}{9b}, \quad (6)$$

such that both firms will go for FDI only if $F < \underline{F}$ or both will produce in the North only if $F > \bar{F}$. Since $\bar{F} - \underline{F} > 0$, also asymmetric equilibria are possible such that one firm goes for FDI but the other does not. The reason is that FDI implies lower marginal costs and hence a larger output, and consequently the world market price will decline. A firm may then improve its profits by unilateral FDI if the FDI cost is moderate, but the other firm will not follow because a further investment and consequently a further decline of the world market price make bilateral FDI not profitable if F is not too low.

We must not expect that outsourcing will resolve the dependency of the equilibrium choices on the size of FDI costs. Table 1 will serve as a point of reference, as we will now explore how outsourcing will change the payoffs for cases in which at least one firm - either incompletely or completely - outsources production of the intermediate input. Furthermore, we will discuss how a change in the degree of spillovers will affect the likelihood of certain outcomes. We start with the case of bilateral outsourcing.

3 Bilateral outsourcing

Let us first assume that both firms will outsource at least a part of their upstream production to the South. If this is the case, both firms are aware that they cannot commit not to produce the intermediate input in the North as well if this is profitable. This section will deal with the case of incomplete outsourcing first, as this analysis will allow us to determine the conditions under which outsourcing will be complete or incomplete.

3.1 Incomplete outsourcing

If both firms continue to produce the intermediate input in the North, the first order condition (2) gives rise to

$$\hat{x}_i = \frac{a - v - 3by_i}{3b}. \quad (7)$$

We denote the equilibrium solutions of the last stage by a hat, and obviously, these depend on the training activities such that $d\hat{x}_i/dy_i = -1$. Note that (7) holds also true for $y_1 = y_2 = 0$ (see (4)). The maximized profits are equal to

$$\hat{\Pi}_i = \frac{(a - v)^2}{9b} + (v - w + \gamma y_j)y_1 - \frac{ty_i^2}{2}. \quad (8)$$

In the second stage, each outsourcing firm anticipates its behavior in the last stage, and maximizes expression (8) w.r.t. y_i . This gives rise to the reaction functions $v - w + \gamma y_i - ty_j = 0$, which shows that training efforts are strategic complements. The equilibrium training level is equal to

$$y_i^* = \frac{v - w}{t - \gamma}. \quad (9)$$

The star denotes equilibrium solutions for the second stage of the game, and we will show soon that $y_i^* > 0$ if incomplete outsourcing occurs. Furthermore, expression (9) shows that training serves also as a commitment device to be more aggressive in the product market. Both firms train more workers than they would if they only minimized cost.⁴ From (9), we are now able to derive the equilibrium home production levels, equilibrium aggregate production and equilibrium profits:

$$x_i^* = \frac{a - v}{3b} - \frac{v - w}{t - \gamma}, Q^* = \frac{2(a - v)}{3b}, \Pi_i^* = \frac{(a - v)^2}{9b} + \frac{t(v - w)^2}{2(t - \gamma)^2}. \quad (10)$$

Notably, x_i^* and y_i^* add up to $(a - v)/3b$, such that Q^* does not depend on γ which proves our first proposition.

Proposition 1 *Aggregate production does not depend on the degree of incomplete outsourcing. Incomplete outsourcing leads to the same aggregate production levels as no outsourcing.*

Proposition 1 shows that consumers will not take advantage of incomplete outsourcing. This is surprising, in particular as firms do training beyond cost saving. But in the last stage, the marginal cost of production is the wage rate in the North, and this is the reason why aggregate production does not change compared to no outsourcing. In case of incomplete outsourcing, both firms correct for the excessive training levels by low production levels in the North. The profits of both firms are larger than the profits given by (5) since both firms do at least partially take advantage of the wage differential. The profits of both firms increase with the degree of spillovers because

$$\frac{d\Pi_i^*}{d\gamma} = \frac{t(v - w)}{(t - \gamma)^3} > 0. \quad (11)$$

⁴Suppose that a firm intends to produce quantity \bar{q} with minimum cost. Minimizing $v(\bar{q} - y_i) + wy_i + ty_i^2/2$ w.r.t. y_i leads to $y_i = (v - w)/t$ which is less than y_i^* . This effect is well-known from the literature on two stage games under imperfect competition. For the seminal paper of an R&D and then output game, see Brander and Spencer (1983).

Both firms benefit from an increase in γ because y_i^* increases, x_i^* decreases and $x_i^* + y_i^*$ remains constant. Since training efforts are strategic complements, profits increase as a larger γ makes both firms enjoy larger positive externalities. Expressions (10) and (11) hold true only for a positive x_i^* which leads us to

Proposition 2 *Incomplete bilateral outsourcing occurs if and only if*

$$t > \frac{3b(v-w)}{a-v} + \gamma.$$

Proposition 2 also demonstrates that y_i^* according to (9) is positive. As $\gamma > 0$, we find

Lemma 1 *Incomplete bilateral outsourcing will not occur if*

$$t < \frac{3b(v-w)}{a-v}.$$

If $t < 3b(v-w)/(a-v) + \gamma$, complete outsourcing will occur. We deal with this case in the next subsection.

3.2 Complete outsourcing

In case of complete outsourcing, the model boils down to a Cournot duopoly model with linear-quadratic production costs. The first order conditions are given by

$$a - v - (2b + t)y_i - (b - \gamma)y_j = 0. \quad (12)$$

$b > \gamma$ implies strategic substitutability, whereas incomplete outsourcing has implied strategic complementarity of training levels. But in this case, there is no further production level in the North to be determined, and the determination of y_i does not involve an incredible threat not to produce in the North. Equilibrium training levels and profits are equal to

$$y_i^* = \frac{a-w}{3b+t-\gamma}, \Pi_i^* = \frac{(2b+t)(a-w)^2}{2(3b+t-\gamma)^2}, \quad (13)$$

respectively. $b > \gamma$ guarantees also that $3b + t - \gamma > 0$. Since

$$\frac{d\Pi_i^*}{d\gamma} = \frac{(2b + t)(a - w)^2}{(3b + t - \gamma)^3} > 0, \quad (14)$$

equilibrium profits increase with the degree of spillovers. This is a substantial result, given that training levels are strategic substitutes. As y_i^* increases with γ , the positive spillover effect is so strong that it offsets the negative effect on world market prices. Based on (14) and (11), we can conclude with

Proposition 3 *In case of bilateral outsourcing, profits rise with the degree of spillovers.*

As for aggregate production, note that there is no production in the North anymore which can compensate for the training efforts in stage 2. Aggregate production and its derivative w.r.t. γ are respectively equal to

$$Q^* = \frac{2(a - w)}{3b + t - \gamma}, \quad \frac{dQ^*}{d\gamma} = \frac{2(a - w)}{(3b + t - \gamma)^2} > 0, \quad (15)$$

which shows that consumers will unambiguously benefit from a larger degree of spillovers. Hence, we may conclude that bilateral outsourcing will change prices only if outsourcing is complete. Furthermore, we have shown that outsourcing will always occur, either incompletely or completely, and hence we must not expect no outsourcing in a symmetric equilibrium without FDI.

4 Outsourcing and foreign direct investment

In this section, we deal with the mixed case. As we consider two different firms, one FDI firm and one outsourcing firm, we will use the subscripts $y(z)$ for the outsourcing (FDI) firm. A remark on the timing is in order now. We will assume that the production level of the FDI firm and the production level in the North will be determined simultaneously in the last stage, after the outsourcing firm has trained workers in the South. The training activities have created a positive externality for the FDI firm which have reduced its marginal costs of production. Hence, the FDI firm has two marginal cost advantages in the last stage: (i) the wage differential, and (ii) the reduction

of marginal costs due to training by the rival firm in the second stage of the game. So the subgame started in stage 2 is a kind of Stackelberg game in which one firm determines at least part of its aggregate production level and this firm and another firm decide on their aggregate production levels in the subsequent stage. As we did in the preceeding section, we will deal with incomplete outsourcing first, which means that the outsourcing firm will continue to produce in the North, before we will turn to complete outsourcing. However, our first result will demonstrate that incomplete outsourcing will not occur, and this is the reason why we will not devote a separate subsection to this case.

Proposition 4 *Unilateral incomplete outsourcing will not occur.*

Proof: The proof can be done by contradiction. Suppose that incomplete outsourcing occurs. From the first order condition (2), taking into account that there is no positive spillover *to* but only *from* the outsourcing firm, we get the equilibrium behavior of the outsourcing firm for stage 3:

$$\hat{x}(y, \gamma) = \max\left\{0, \frac{a - 2v + w - (3b + \gamma)y}{3b}\right\}. \quad (16)$$

From (16), we conclude that

$$\hat{x}(y, \gamma) = 0 \text{ if } y \geq \frac{a - 2v + w}{3b + \gamma}. \quad (17)$$

The maximized profit of the outsourcing firm is equal to

$$\begin{aligned} \hat{\Pi}_y &= \frac{(a - 2v + w - \gamma y)(a + v + w - \gamma y)}{9b} \\ &\quad - \frac{v(a - 2v + w - (3b + \gamma)y)}{3b} - wy - \frac{t}{2}y^2. \end{aligned} \quad (18)$$

Maximization of (18) leads to an optimal level of training of⁵

$$y^*(\gamma) = \frac{9b(v - w) - 2\gamma(a - 2v + w)}{9bt - 2\gamma^2}. \quad (19)$$

⁵Furthermore, $t > 2\gamma^2/9b$ is required to meet the second order condition.

$y^*(\gamma)$ is consistent with condition (17) if and only if

$$\gamma < \frac{3(3b(v-w) - t(a-2v+w))}{2a-7v+5w}. \quad (20)$$

Eq. (19) implies an optimal production level in the North of

$$x^*(\gamma) = \hat{x}(y^*(\gamma), \gamma) = \frac{\gamma(2a-7v+5w) - 3(3b(v-w) - t(a-2v+w))}{9bt - 2\gamma^2}. \quad (21)$$

$x^*(\gamma) > 0$ if only if

$$\gamma > \frac{3(3b(v-w) - t(a-2v+w))}{2a-7v+5w} \quad (22)$$

which contradicts condition (20). \square

Proposition 4 demonstrates that outsourcing will be complete if it happens at all. With complete outsourcing, the model becomes very similar to a Stackelberg model in which the Stackelberg leader has linear-quadratic production costs. From Proposition 4, we may derive

Lemma 2 *In case of unilateral outsourcing, complete (no) outsourcing will occur if*

$$\gamma < (>) \frac{3(3b(v-w) - t(a-2v+w))}{2a-7v+5w}.$$

Furthermore, as $\gamma > 0$, we have

Lemma 3 *If*

$$t > \frac{3b(v-w)}{a-2v+w},$$

no unilateral outsourcing will occur.

For complete outsourcing, solving for the first-order conditions for the FDI firm yields

$$\hat{z}(y, \gamma) = \max\left\{0, \frac{a+v-2w+2\gamma y}{3b}\right\}. \quad (23)$$

From (23), we conclude that

$$\hat{z}(y, \gamma) = 0 \text{ if } y \geq \frac{a + v - 2w}{3b} > \frac{a - 2v + w}{3b + \gamma}$$

(compare with 17). We may now distinguish two cases, to which we will refer as monopolization and no monopolization. In the first case, the outsourcing firm will not train more than $(a + v - 2w)/3b$ workers and thus will allow for competition by the FDI firm, but in the case of monopolization, y is larger than $(a + v - 2w)/3b$ and the outsourcing firm will consequently be the only firm serving the market.

4.1 No monopolization

The first order condition for the completely outsourcing firm leads to respective output and profit levels

$$\begin{aligned} y^*(\gamma) &= \frac{a - w}{2(b + t + \gamma)}, z^*(\gamma) = \frac{(a - w)(b + 2t + 3\gamma)}{4b(b + t + \gamma)}, \\ \Pi_y^* &= \frac{(a - w)^2}{8(b + t + \gamma)}, \Pi_z^* = \frac{(a - w)^2(b + 2t + 3\gamma)^2}{16b(b + t + \gamma)^2} - F. \end{aligned} \quad (24)$$

From expression (24), we may derive

$$\frac{d\Pi_y^*}{d\gamma} = -\frac{(a - w)^2}{8(b + t + \gamma)^2} < 0, \frac{d\Pi_z^*}{d\gamma} = -\frac{(a - w)^2(2b + t)(b + 2t + 3\gamma)}{8b(b + t + \gamma)^3} > 0 \quad (25)$$

which proves

Proposition 5 *The outsourcing firm's profit will unambiguously decrease with the spillover parameter, whereas the FDI firm will unambiguously gain by a larger spillover.*

The reason is that an increase in γ makes the outsourcing firm reduce its production level, as shown here:

$$\frac{dy^*}{d\gamma} = -\frac{a - w}{2(b + t + \gamma)^2} < 0, \frac{dz^*}{d\gamma} = \frac{(a - w)(2b + t)}{4b(b + t + \gamma)^2} > 0. \quad (26)$$

This reduction in production makes the price rise, and the FDI firm will produce more in response to this price rise. A crucial difference from the case of bilateral outsourcing is the behavior of aggregate production:

$$\frac{dQ^*}{d\gamma} = -\frac{t(a-w)}{4b(b+t+\gamma)^2} < 0. \quad (27)$$

Eq. (27) shows that the decline in production by the outsourcing firm is not offset by the increase in production by the FDI firm, despite the fact that they face the same wage rate. Hence, consumers will not benefit from an increase in spillovers if outsourcing is unilateral.

4.2 Monopolization

In the second case, the outsourcing firm trains so many workers that the FDI firm is not able to cover its marginal costs. Monopolization requires $x = z = 0$ and warrants that $y \geq (a-w)/2(b+t+\gamma)$. The optimal y^* according to (24) coincides with $(a-w)/2(b+t+\gamma)$ if γ is equal to

$$\frac{a(b-2t) - 2(b+t)v + (b+4t)w}{2(a+v-2w)} \equiv \gamma'. \quad (28)$$

If $\gamma \leq \gamma'$, outsourcing will not only be complete but will also monopolize the market. This may happen if and only if $\gamma' > 0$ which requires

$$t < \frac{b(a-2v+w)}{2(a+v-2w)}. \quad (29)$$

Condition (29) requires a not too large training cost parameter in order to allow a positive γ which is less than γ' . If this is the most profitable outsourcing strategy, however, we can safely conclude that monopolizing outsourcing can never qualify for an equilibrium. The reason is that unilateral and monopolizing outsourcing implies that an FDI firm sinks FDI costs F without producing a single unit. This firm would definitely make losses of size F , and it would prefer to become an outsourcing firm as well. We may summarize this result by

Proposition 6 *If $\gamma' > 0$ and $\gamma \in [0, \gamma']$, unilateral outsourcing will never occur.*

5 Summary and conclusions

The preceding sections have demonstrated how outsourcing affects profits and outputs of outsourcing and FDI firms. As mentioned in Section 2, adding an outsourcing option to the standard trade and FDI model will not resolve the dependency of the equilibrium on the size of FDI costs. However, we may draw some conclusions on the likelihood of certain firm type combinations. For this purpose, we may distinguish two cases. Due to Lemma 3, no unilateral outsourcing will occur if $t > 3b(v - w)/(a - 2v + w)$. Due to Lemma 1, incomplete bilateral outsourcing will not occur if $t < 3b(v - w)/(a - 2v + w)$. Hence, we may distinguish between

- the case of high training costs which allows
 - incomplete and complete bilateral outsourcing, but
 - no unilateral outsourcing, and
- the case of low training costs which allows
 - complete bilateral outsourcing and
 - complete unilateral outsourcing only.

Table 2: Payoff matrix with bilateral outsourcing

| | | Firm 2 | |
|--------|--------|---|---|
| | | No FDI | FDI |
| Firm 1 | No FDI | (Π_i^*, Π_i^*) | $\left(\frac{(a-2v+w)^2}{9b}, \frac{(a-2w+v)^2}{9b} - F\right)$ |
| | FDI | $\left(\frac{(a-2w+v)^2}{9b} - F, \frac{(a-2v+w)^2}{9b}\right)$ | $\left(\frac{(a-w)^2}{9b} - F, \frac{(a-w)^2}{9b} - F\right)$ |

Table 2 shows the payoff matrix in case of high training costs. Π_i^* is either equal to profits in expression (10) (for incomplete outsourcing) or to profits in expression (13) (for complete outsourcing). Table 2 differs from Table 1 only by the no FDI – no FDI – entry. Most importantly, maximized profits increase with the degree of spillovers such that an increase in γ will increase the

likelihood of a symmetric outsourcing equilibrium. However, if outsourcing will be incomplete, consumers will be served at the same price as without outsourcing, and will unambiguously lose compared to FDI. Furthermore, the decline in production in the North may cause adverse employment effects.⁶ Both effects may explain why workers in the North can be expected to be hostile to outsourcing. If bilateral outsourcing is complete, prices decline but no production takes place in the North at the same time.

Table 3: Payoff matrix with complete outsourcing

| | | Firm 2 | |
|--------|-------------|---|---|
| | | Outsourcing | FDI |
| Firm 1 | Outsourcing | $\left(\frac{(2b+t)(a-w)^2}{2(3b+t-\gamma)^2}, \frac{(2b+t)(a-w)^2}{2(3b+t-\gamma)^2} \right)$ | $\left(\frac{(a-w)^2}{8(b+t+\gamma)}, \frac{(a-w)^2(b+2t+3\gamma)^2}{16b(b+t+\gamma)^2} - F \right)$ |
| | FDI | $\left(\frac{(a-w)^2(b+2t+3\gamma)^2}{16b(b+t+\gamma)^2} - F, \frac{(a-w)^2}{8(b+t+\gamma)} \right)$ | $\left(\frac{(a-w)^2}{9b} - F, \frac{(a-w)^2}{9b} - F \right)$ |

Table 3 shows the payoff matrix in the case of low training costs. Both unilateral and bilateral outsourcing is complete. The equilibrium depends on parameter values, and both symmetric and asymmetric outcomes may qualify for an equilibrium. The effect on consumers depends on the type of the equilibrium. Notably, we have observed that aggregate production declines with the degree of spillovers if the equilibrium is asymmetric. At the same time, production in the North increases with γ as the outsourcing firm shifts production from the South to the North in order to reduce the spillover effect and the price increases. In case of bilateral outsourcing, no production will take place in the North and aggregate production increases with γ .

In summary, outsourcing and spillovers from outsourcing do not lead to unambiguous results for production and firm types, but these depend crucially on the size of training costs and the size of the spillover. Furthermore, our model has not endogenized the wages rates in the North and in the South, and it may be expected that general equilibrium effects will not resolve this

⁶We do not consider equilibrium effects of outsourcing on wages but assume that w does not change.

ambiguity. The overall effect depends on the type of labor market. In case of labor market rigidities, outsourcing is likely to increase unemployment in the North and increase employment in the South. However, the strength of this effect depends on training costs and the degree of spillovers as well.

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